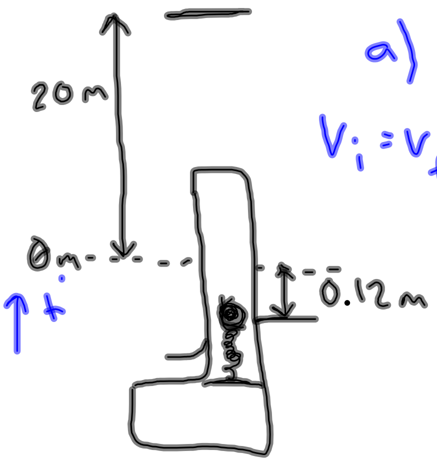
Work and Energy Notes and Practice Problems 9.26.11 AP Physics

The launching mechanism of a popgun consists of a spring of unknown spring constant. When the spring is compressed 0.120 m, the gun, when fired vertically, is able to launch a 35.0 g projectile to a maximum height of 20.0 m above the position of the projectile as it leaves the spring.
a) Neglecting all resistive forces, determine the spring constant.
b) Find the speed of the projectile as it moves through the equilibrium position of the spring.



a) $K_i^{\nearrow 0} + U_{gi} + U_{si} = K_f^{\nearrow 0} + U_{gf} + U_{sf}^{\nearrow 0}$

$v_i = v_f = 0 \text{ m/s}$

$U_{gi} + U_{si} = U_{gf}$

$mgy_i + \frac{1}{2}kx_i^2 = mgy_f$

$m = .035 \text{ kg}$

$y_i = -.12 \text{ m}$

$y_f = 20 \text{ m}$

$x_i = -.12 \text{ m}$

$k = \frac{2}{x_i^2}\left[mgy_f - mgy_i\right]$

$= 958 \text{ N/m}$

b) $E_i = E_f$

$v_i = 0 \text{ m/s}$ $\quad K_i^{\nearrow 0} + U_{gi} + U_{si} = K_f + U_{gf}^{\nearrow 0} + U_{sf}^{\nearrow 0}$

$x_i = -.12 \text{ m}$

$y_i = -.12 \text{ m}$

$x_f = 0 \text{ m}$

$y_f = 0 \text{ m}$

$v_f = ?$

$mgy_i + \frac{1}{2}kx_i^2 = \frac{1}{2}mv_f^2$

$v_f = \sqrt{2gy + \frac{kx_i^2}{m}}$

$= 19.8 \text{ m/s}$

How do we include friction?

$$W_{net} = \Delta K + \Delta U$$

$$\Sigma F \, d \cos\theta = \Delta K + \Delta U$$

$$(F_A - F_{fk}) \, d \cos\theta = \Delta K + \Delta U$$

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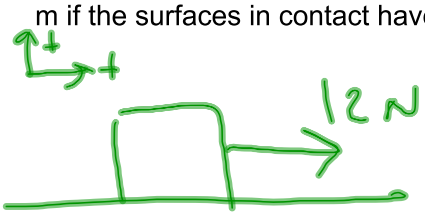
A 6.0 kg block initially at rest is pulled to the right along a horizontal surface by a constant horizontal force of 12 N. Find the speed of the block after it has moved 3.0 m if the surfaces in contact have a coefficient of kinetic friction of 0.15.



$$W = \Delta E$$

$$= \Delta K + \cancel{\Delta U}$$

$$= \frac{1}{2} m v_f^2 - \cancel{\frac{1}{2} m v_i^2} \rightarrow 0$$

$$\sum F \, d \cos\theta = \frac{1}{2} m v_f^2$$

$$(F_A - F_{fk}) \, d \cos\theta = \frac{1}{2} m v_f^2$$

$$(F_A - \mu_k F_N) \, d \cancel{\cos\theta}^{\,1} = \frac{1}{2} m v_f^2$$

$$(F_A - \mu_k m g) \, d = \frac{1}{2} m v_f^2$$

$$v_f = \sqrt{\frac{2}{m}\left[(F_A - \mu_k m g) d\right]}$$

$$= 1.78 \text{ m/s}$$